25X1

PAR 202
30 Nov 64

SUBJECT: Briefing Print Enlarger

TASK/PROBLEM

1. To design and build a prototype enlarger for exposing high-quality briefing prints in formats up to and including 20 x 24 inches in size. Magnification to be in the 10 - 60 diameter range. The enlarger will be able to produce both black-and-white and color prints. Changing from one capability to the other should be made with a minimum of effort.

DISCUSSION

2. This project is proceeding with close correlation to the work on PAR 224. Work on these projects during the quarter has been on:

a. Vacuum Platen and Carriage

(1) The layout and detail drawings of the following more complex parts have been completed:

(a) Platen
(b) Platen carriage
(c) Carriage track, and
(d) Carriage drive and position indexing assembly

(2) Work has been started on the assembly which will display the table of magnification and lens focus settings and indicate the item in the table which corresponds to the platen position.

(3) Two large castings, the platen body and the platen carriage, have been discussed with engineers in a local foundry and have been ordered.

(4) About 50 percent of the design and drafting effort for the assembly is completed.

b. Negative Transport

(1) The first assembly of the breadboard model of this unit was made during the first period of the quarter. A ball-spline support for the film spool outrigger arm proved unsatisfactory and has been replaced by a ball-bushing and key arrangement. With this spool support, it has been possible to align the model to run 70mm and 9.5 inches wide thin base film in both directions. There are random variations of the tracking of the film into the take-up spool, particularly with 70mm film, which produces some crowding against the spool flange and slight, non-permanent turning of the film edge. The film tracking shifts through a range of about one-eighth-inch at the roll ahead of the take-up spool. The position of the film web on that roll appears related to the particular portion of web being run across.

(2) Layout and detail design of back-illuminated transparent scales for X- and Y-coordinate indication on the transport model are nearly complete. The major problem has been to design a low-drag, low-momentum system for the X-coordinate (along frame) indicator to operate from a film-driven metering roll and which need not be uncoupled when winding the film at high speed. A system providing similar presentation of readout to the operator and using several common parts is being designed for Y-coordinate indication.

(3) Use of the transport for the film tracking tests has shown that refinement in motor and brake torque controls will be necessary.

c. Main Frame: During the last period, the layout of the main frame and its shock mounting system has progressed well.

d. Condenser System, Film Gate, and Objective Lens Focus System: The optical elements of the six condenser systems have been released for fabrication. It will be necessary to adjust the focus of the condenser system as the objective lens focus is changed for only the three lowest

magnification ranges. Mechanical design studies in this area were started late in the quarter, and no layouts have been established.

e. Objective Lens Designs:

(1) The lens designs required to provide 10X to 60X magnification to 20 x 24 inch prints for PAR 202 and to provide the 3X to 15X magnification from 70mm square negative area for PAR 224 have been specified and designed as a series of six lenses to provide a continuous range of magnification with an over-all conjugate length range of 50 to 80 inches for each lens. Two series of lenses were specified and designed, one series for making black-and-white prints with a narrow spectrum band centered about 4600A and the second series for making color prints with three narrow spectrum bands centered at 4500A, 5500A, and 6500A. The designs of both of these series are now complete with the exception of the 40X to 60X lens in the color series which is expected to be completed momentarily.

(2) These lenses have been designed by the contractor's lens group on an automatic optimization computer program (LEAD). As the designs for the color series progressed, there was indication that one series of lenses could be designed to meet both requirements. By the end of the quarter, we had designs for "combination" lenses for three of the magnification ranges and strong indication that two others will soon be available. A combination design is not possible for the 40X to 60X range. Table 1 summarizes the lens design effort.

(3) In "combination" lens designs to be used for either black-and-white or color printing, it appears necessary to operate at about "one stop" smaller aperture (larger f/number) for color printing in comparison to black-and-white printing. There will also be a difference in the focus setting for the two applications. The differences in image quality and their dependence upon relative aperture and the magnitude of the focus shift must be measured on the sample lenses.

TABLE 1

Lens Designs
for
PAR 202 and PAR 224 Enlargers

| Magn. Range and E.F.L. | B&W Printing Only | Combination | Color Printing Only |
|---|---|---|---|
| 2.5X to 5.3X 10.7" | Form 8-L-11 f/17.8 | Form 18-L-28[A] B&W f/17.8 Color f/26 | Not Designed |
| 4.75 to 9X 7.2" | Not Designed | Form 12-J-25[A] B&W f/12 Color f/18 | Not Designed |
| 8.55X to 15X 4.7" | Form 4-M-49 f/7.8 | In Design | Form 12-M-337 f/12.0 |
| 14.5X to 24.7X 3.0" | Form 4-M-49 f/5.0 | In Design | Form 6-M-336 f/8.0 |
| 24.2X to 40.2X 1.90" | Form 4-M-49 f/4.2 | Form 6M-338[B] B&W f/4.2 Color f/6.0 | Form 6-M-336 f/6.0 |
| 38X to 62.5 1.25" | Form 28-N-101[B] f/2.8 | Not Feasible | In Design |

[A] Lenses released for sample fabrication.
[B] Lenses approved for sample fabrication but not yet released at publication date of this report.

f. Lens Focus Setting and Magnification Table:

(1) In the enlarger development effort, we are planning to use manual setting of the objective lens focus. The lens assembly and the platen assembly are each equipped with precision linear position scales. The platen carriage drivers are being designed to position the carriage only at discrete points 0.200 inches apart within its 30 inch range of travel. A numeric table is to be supplied to show the Lens Focus Scale setting and the magnification value for each of the 150 discrete platen positions for each of the lenses.

(2) A computer program in Fortran II for the IBM 1620 computer has been written to calculate the values for the table for each lens from calibration data of the best photographic focus at three overall conjugate lengths. The working of this program is based upon computing adjusted values of lens E.F. and the front-focal-point to rear-focal-point separation for substitution in the lens formula. Testing of this program with hypothetical input data showed that the expected experimental errors in the measurement of best photographic focus would create such large changes in the adjusted E.F. and the focal point separation that they could not be used safely for computing magnification. The computing program concept must be revised and the program rewritten.

PLANNED ACTIVITY

3. Effort in the next quarter will be to:

a. Continue test and evaluation of the film tracking characteristics of the negative transport and consider the possible need and means for servo control of the negative transport. The torque motor and brake controls will be refined.

b. Complete the objective lens design and begin fabrication of the remaining five samples.

c. Complete mechanical layouts and detail design and release for fabrication all parts of the breadboard model.

d. Revise and test with hypothetical input data, the computer program for the Focus and Magnification Table.